Limits of geostrophic dynamics at the ocean surface: Guidance for planning SWOT's mission and products

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geostrophic analysis: measure η and calculate $\mathbf{u} \approx \mathbf{u}_g$ from

$$\mathbf{u}_g = \frac{g}{f} \hat{\mathbf{z}} \times \nabla_h \eta$$

with the presumption that it is superimposable with wind-driven Ekman currents.

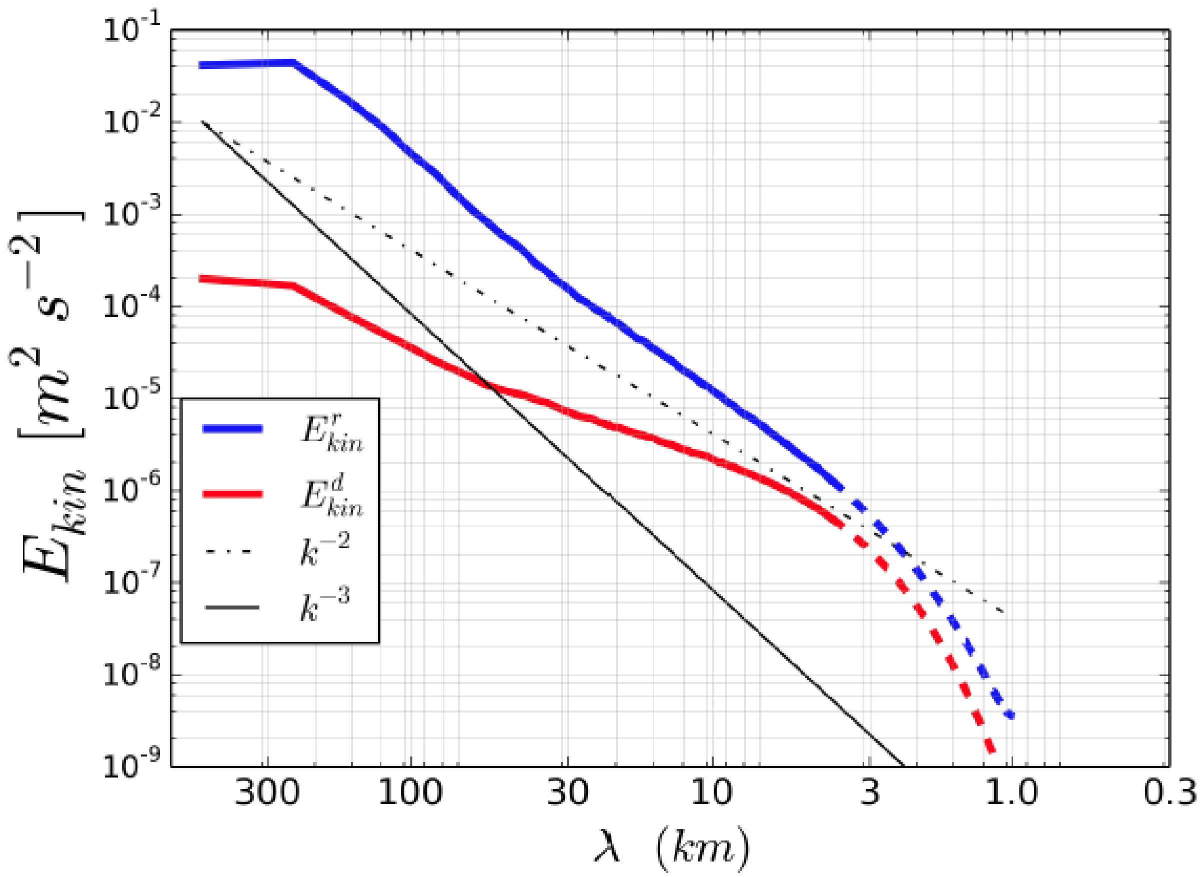
This framework has served us very well for present altimetry measurements of **large-mesoscale** eddies with wavelength λ > 100-200 km.

At smaller λ this relation begins to be **inaccurate**. Consider a Helmholtz decomposition of surface velocity: $\mathbf{u}_h = \mathbf{u}_{rot} + \mathbf{u}_{div}$.

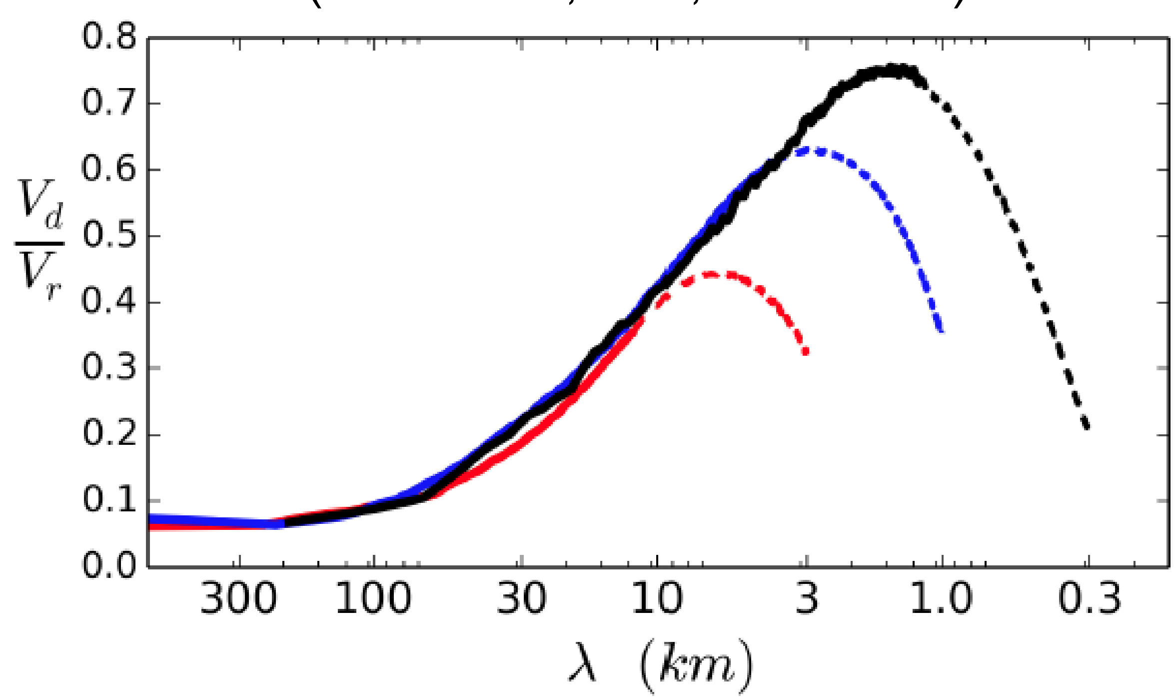
- The cyclostrophic correction to geostrophic balance often matters.
- $\mathbf{u}_{div}$ becomes comparable to $\mathbf{u}_{rot}$.
- η has internal wave components that contaminate $\mathbf{u}_g$, even though $\mathbf{u}_h$ itself is mostly balanced.

e.g., the Gulf Stream with several nested resolutions

kinetic energy spectrum components (dx = 500 m)



divergent/rotational ratio (dx = 1.5, 0.5, 0.15 km)



“geostrophic”/rotational ratio (dx = 1.5, 0.5, 0.15 km)